Claims

1. A link assembly for a robot arm which arm comprises first and second link members each adapted for limited movement one with respect to the other and resilient elastomer means disposed between said first and second members characterised in that the first and second members are configured in a cooperating mating relationship and the elastomer means is disposed between them as a thin layer and the elastomer means is keyed or bonded to both of the first and second link members whereby a bending movement between the members produces shear movement within the elastomer means and reduces any compressive movement as a result of the relative movement between the said first and said second members.

2. A link assembly as claimed in claim 1 wherein the elastomer is a natural or synthetic rubber.

3. A link assembly as claimed in either preceding claim wherein the elastomer is disposed as a layer between said first and second linked members.

4. A link assembly as claimed in any one of the preceding claims wherein the thickness of the layer is 3 mm or less.

5. A link assembly as claimed in any one of the preceding claims wherein the elastomer layer may be bonded and/or keyed to one or both of said members.

6. A link assembly as claimed in claim 5 wherein each surface of the elastomeric layer contiguous the member is effectively secured so that in operation, relative movement between the members produces shear movement within the elastomer, the arrangement being such that the thinness of the layer reduces the tendency towards compression thereby imparting improved stability for the positioning of the components.

7. A link assembly as claimed in any preceding claim wherein the elastomer means comprises a plurality of layers of elastomer.

8. A link assembly as claimed in claim 7 wherein a rigid layer is bonded or keyed to adjacent elastomer layers to separate one layer from its neighbour.

9. A link assembly as claimed in claim 7 or 8 wherein the elastomer means is a laminate.

10. A link assembly as claimed in any one of claims 7 to 9 wherein the interleaving or rigid layer between each layer of elastomer is of a material, which is bondable to or capable of being keyed to the elastomer.

11. An assembly as claimed in claim 10 characterised in that the interleaving layer is sufficiently stiff to reduce compression of the elastomer to a minimum during movement of the linked members.

12. An assembly as claimed in any one of claims 7 to 11 wherein the interleaving layer may comprise a thin metal layer, a resin or glass fibre or a mat of either woven or unwoven material.

13. An assembly as claimed in claim 12 wherein the woven or unwoven material may be carbon fibre or Kevlar.

14. A link assembly for a robotic arm substantially as herein described with reference to and as illustrated in the accompanying drawings.

15. A robotic arm comprising a segment having a plurality of links as claimed in any one of claims 1 to 14 and control means for controlling the movement of said links within the segment wherein the control means maintains said links under tension or compression.

16. A robotic arm as claimed in claim 15 wherein the control means may comprise at least one wire extending from one end of the segment to the other.

17. A robotic arm as claimed in claim 15 or claim 16 wherein the control means may comprise three wires each extending from one end of the segment to the other whereby changing the tension in the wires one relative to the other causes or allows the links to flex thereby controlling movement of the segment.

18. A robotic arm as claimed in any one of claims 15 to 17 wherein the wires are preferably tensioned to maintain the links under compression, the arrangement being such that application of differential tension between the wires causes or allows the segment to move or bend.

19. A robotic arm as claimed in any one of claims 15 to 18 wherein each link comprises an outer disc having holes for control wires so that the control wires extend externally of the other components of the link, an inner disc which is adapted to be disposed generally inwardly of the outer disc and which has a central bore to accommodate control and/or power means for the work head and a rubber disc or layer extending between each inner and outer disc which is bonded or keyed to each, but which is otherwise free-

floating between said inner disc and outer disc so that the inner disc is not directly constrained by other components of the assembly.

20. A robotic arm as claimed in claims 15 to 19 comprising a plurality of segments in accordance with the invention as claimed in any one of the preceding claims in which control means is provided for each segment.

21. A robotic arm as claimed in claim 20 wherein each segment terminates in an end cap having wire conduit means for the control wires of other segments of the arm and anchorage means arcuately spaced about the cap for securing the control wires for the segment in question.

22. A robotic arm as claimed in any one of claims 15 to 21 wherein at least one of the members of each link is provided with means for guiding the wires from one end of the segment to the other.

23. A robotic arm as claimed in any one of claims 15 to 22 wherein each wire is disposed externally of the segment links and terminates in a ferrule which is adapted to engage with a corresponding recess in the end cap of a segment so that on tensioning the wires, the ferrule is brought into engagement with the end cap to exert a compressive load on each of the links to maintain the stiffness of the links within the segment.

24. A robotic arm as claimed in any one of claims 20 to 23 characterised in that each control wire is operated by an actuator and wherein the actuators associated with each control wire are spaced in one or more arcs about the headboard contiguous one end of the first segment.

25. A robotic arm as claimed in claim 24 wherein the actuator array provides one actuator for each wire to be disposed in a spaced arcuate relationship to define a frustocone, further characterised in that the wire from each actuator is passed about a guide or pulley to provide a fair lead for the control wire from the actuator to the entry into the segment.

26. An assembly or arm as claimed in any preceding claim wherein each link is produced as a pair of half links which may be assembled back to back, the arrangement being such that an inner link and an outer link halves may be assembled with its associated bonding layer to form unitary link components, a plurality of which together can be assembled to form a segment.

27. An assembly or arm as claimed in claim 26 characterised in that each half linked component comprises three separate individual elements, namely an outer link element, an inner link element and the rubber bearing characterised in that the bearing is keyed or bonded to each of the link

elements so that on attempting to move one component relative to the other, shear movement or force is generated within the rubber component.

28. An assembly or arm as claimed in claim 27 wherein each of the half links can be located by means of locating dowels provided in mating holes on each of the assembled half-links whereby the assembly can be produced without further connection between the half-linked components and cables can be threaded through the various operating holes in the outer link periphery coupled to the actuator board, the arrangement being such that the actuators can be activated to produce a degree of tension in the board and in the cables whereby the whole assembly is held together so that by varying the tension in the wires, the segment can be manipulated as appropriate.

29. An arm as claimed in any one of claims 15 to 28 characterised by an external sleeve provided about each segment.

30. An arm as claimed in any one of claims 15 to 29 wherein the sleeve may be a bellows-type sheath.

31. An arm as claimed in any one of claims 15 to 30 wherein the material of the sheath and its configuration is selected to increase the tortional stiffness of the arm with very little increase in bending stiffness.

32. An arm as claimed in any one of claims 29 to 31 wherein the sheathed segment is filled with a lubricant.

33. An arm as claimed in claims 29 to 32 wherein the lubricant is a either dry powder or a liquid such as grease and/or oil and wherein the physical characteristics of the lubricant incorporated in the arm are selected according to the environment in which the arm is to operate.

34. An arm as claimed in any one of claims 31 to 33 wherein the arm may be provided with a lubricant reservoir and means for pumping lubricant through the arm and recycled back to the reservoir.

35. An arm as claimed in claim 34 wherein lubricant cooling means are provided for cooling the arm when used in an aggressive environment.